MAP MF-1597-B

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

GEOPHYSICAL SURVEY MAP OF THE WASHAKIE WILDERNESS AND ADJACENT ROADLESS AREAS, PARK COUNTY, WYOMING

By Carl L. Long

MISCELLANEOUS FIELD STUDIES MAP
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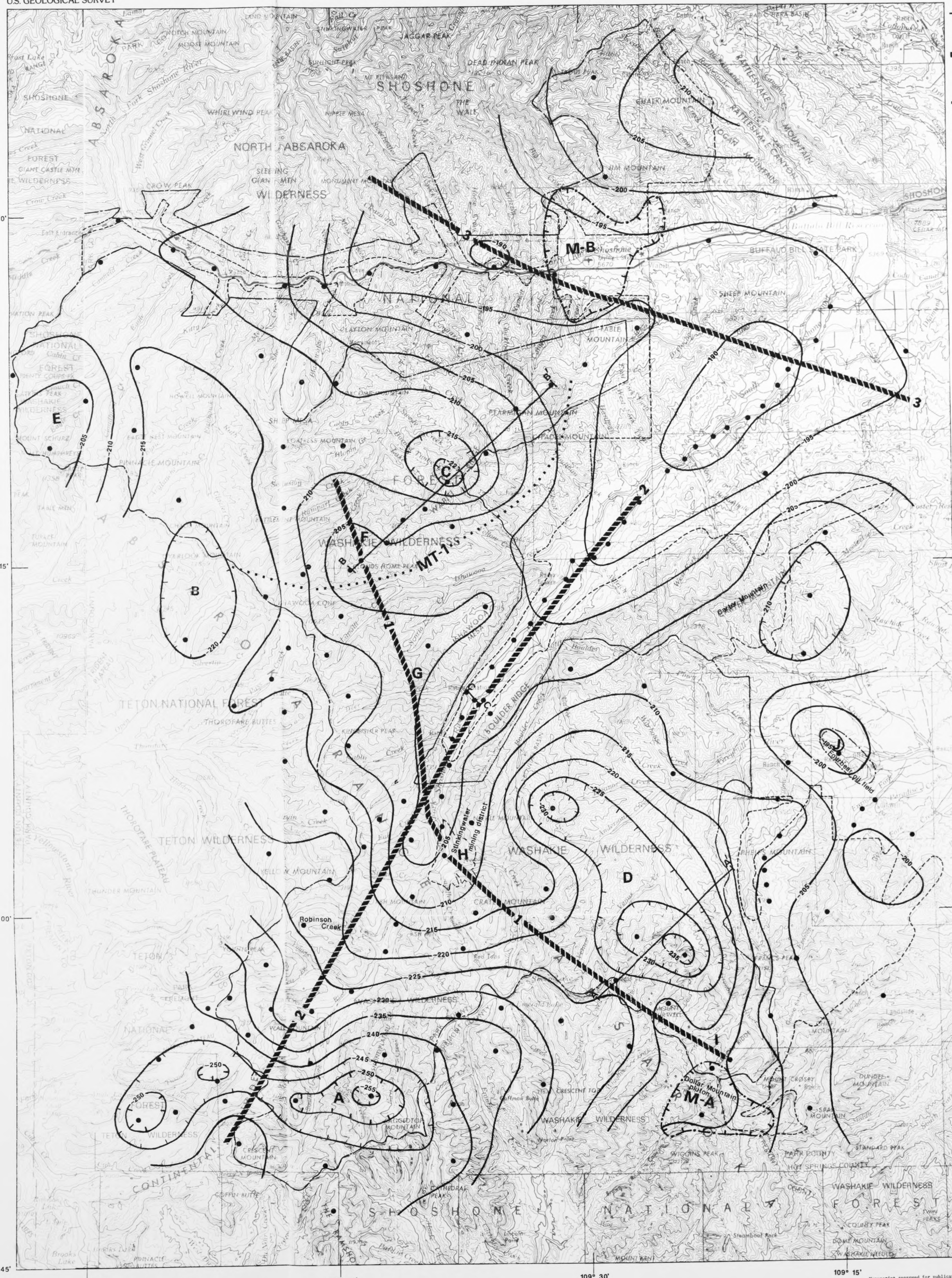
MISCELLANEOUS FIELD STUDI
MAP MF-159



Base from U.S. Geological Survey 1:250,000
Ashton, Cody, Driggs, Thermopolis

SCALE 1:125 000
2 0 2 4 6 8 MILES
2 0 2 4 6 8 KILOMETERS
CONTOUR INTERVAL 200 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Manuscript approved for publication
December 21, 1988

EXPLANATION

- 210 — Complete Bouguer gravity contour--Contour interval 5 mGal. Bouguer reduction density 2.67 gm/cm³. Includes terrain corrections to a distance of 166.7 km. Hachures indicate area of closed low
- 1 — Gravity trend
- A — Gravity anomaly
- Gravity station
- MT-1 — Magnetic trend
- M-A — Magnetic anomaly--Hachures indicate area of closed low
- Approximate boundary of wilderness area
- Approximate boundary of roadless area

STUDIES RELATED TO WILDERNESS

The Wilderness Act (Public Law 88-577, September 3, 196 and related Acts require the U.S. Geological Survey and the U.S. Bureau of Mines to survey certain areas of Federal lands to determine what mineral values, if any, may be present. Results must be made available to the public and be submitted to the President and the Congress. This report presents the results of aeromagnetic and gravity surveys of the Washakie Wilderness and adjacent roadless areas. The U.S. Forest Service combined the South Absaroka Wilderness, the Stratified Primitive Area, and the DuNoir Addition into a single entity called the "Washakie Wilderness" in 1972.

INTRODUCTION

The study area is east and southeast of Yellowstone National Park and west of the Bighorn basin (fig. 1). It is underlain largely by the Absaroka Volcanic Supergroup of Eocene age. The volcanic field is composed of coalescing stratovolcanoes that have been deeply eroded and form steep-sided canyons that locally expose shallow plutons, some of which are accompanied by radiating dike swarms.

Gravity and aeromagnetic surveys were conducted in the Washakie Wilderness and adjacent roadless areas to supplement geological and geochemical studies of the area. Gravity data were collected by Long (1982) and supplemented with data from gravity surveys of D. M. Kulik (Antweiler and others, 1985) and surveys on file with the U.S. Defense Mapping Agency. The aeromagnetic survey was flown in 1969 by the U.S. Geological Survey. The gravity and magnetic surveys provide information on the large scale or regional elements of the lithology and geologic structures, and how they relate to the oil, gas, and mineral resource potential of the area.

GRAVITY SURVEY

METHODS

Gravity observations were made using a LaCoste-Romberg meter G-17 and were referenced to base station ACIC 1651-1 of the International Gravity Standardization Net, 1971 (U.S. Defense Mapping Agency, Aerospace Center, 1974) at Cody, Wyo. Gravity loops were closed daily using a temporary base established near the working area and tied to the Cody base station. More complete description of the base station, data-reduction method, and a listing of the gravity data are in Long (1982). An average rock density of 2.67 grams per cubic centimeter (gm/cm³) was assumed for reducing these data to the complete Bouguer anomaly map, contoured at 5-milligal (mGal) intervals. The low station density permits only the gravity anomalies of larger horizontal dimensions to be analyzed.

GRAVITY DATA

The gravity data are characterized by several northwesterly trends that parallel the Laramide breakup of the Wyoming foreland structures to the east (Sales, 1968).

Most of the volcaniclastic rocks of the southern Absaroka Range are flatlying or only gently dipping (Rankin, written commun.), which implies that they were deposited in a nearly flat basin. Evidence of this basin can be implied from several gravity lows (A, B, and D on map) that encircle the central part of the range. The largest of these lows (anomaly A) starts at the southwest edge of the study area and extends into the Teton Wilderness area in the southeast corner of the map area. This low has been named the "Younts gravity basin" by D. M. Kulik (Antweiler and others, 1985). Smaller gravity lows B and D may be indicative of remnants of a basin that existed prior to the intrusive and extrusive rocks of the Absaroka Volcanic Supergroup.

The denser rocks of the intrusives and associated dike swarms of the range are reflected in the gravity highs at E, F, G, H, and I, which are coincidental with the major plutons. The alignment of gravity highs at F, G, H, and I forms a northwest gravity trend, trend 1, and implies that a deep basement fracture zone may have existed and created a conduit for the related intrusive and extrusive rocks of the Absaroka Volcanic Supergroup. Most of the 11 known mineralized sites (Fisher, 1981) correlate well with the gravity highs along trend 1 and trend 2 and may imply that they are all of similar origin.

A major northeast-southwest high in the gravity contours, trend 2, parallels the South Fork Shoshone River and intersects gravity trend 1. The coincidence of these trends may be indicative of two major basement fractures associated with the development of the large Stinkingwater mining district (Rankin, written commun.) at their intersection. Continuation of gravity trend 2 southwestward is suggestive of a similar fracture zone that may have provided access to the intrusion at Robinson Creek, which is about 7.5 mi southeast of the two intersecting trends. Implications are that this gravity trend may be a northeast-trending tear fault associated with the left-lateral couple of major blocks, as suggested by Sales (1968) in his dragfold concept for the formation of the Wyoming ranges.

A broad gravity high having two closures, trend 3, is evident across the northern edge of the study area. This high trends northwesterly and is parallel with one of the anticlinal features to the southeast and east (Nelson and others, 1980).

The central part of trend 3 is coincidental with a northwest line of oil seeps emerging from the volcanic rocks along a structural shelf (Antweiler and others, 1985). This gravity trend is continuous to the northwest, which implies that it may be part of a major structural block, possibly the southeastern end of the Beartooth uplift, located northwest of the mapped area. The steep gravity gradient along the southeast edge of this trend may be indicative of the continuation of the Gardiner fault (Ruppel, 1972; Foose and others, 1961) to the southeast beyond where the fault has been previously mapped.

Southeast of trend 3 mid-way down the map, gravity high J is centered over a known anticlinal feature in the area of the Fourbear oil field (Antweiler and others, 1985); anomaly J may indicate a Precambrian high, which could extend beneath the volcanics of Carter Mountain.

GRAVITY MODELS

Two-dimensional gravity models calculated for gravity profiles A-A', B-B', and C-C' are shown on figures 2, 3, and 4. Structural cross sections were unavailable for control; therefore the implied structures are only hypothetical and are based on assumed densities. To be consistent with gravity profiles shown in the report on the adjoining Teton Wilderness (Antweiler and others, 1985), the same density contrasts were used. An average density of 2.73 gm/cm³ was assumed for Precambrian rock, 2.66 gm/cm³ for Paleozoic rocks, 2.54 gm/cm³ for Mesozoic rocks, and 2.53 gm/cm³ for Tertiary rocks.

The implied structure of the model of gravity profile A-A'(fig. 1) is only qualitative and other configurations are possible. The low anomaly reflects a graben-like feature having about 11,500 ft of low-density material at its thickest point, possibly Tertiary and pre-Tertiary sediments. This structural low implied by the model may be indicating buried folding and faulting similar to that which occurred during the Laramide orogeny east of the study area (Nelson and others, 1980). Tertiary and Mesozoic rocks have similar assumed densities; therefore the relative thickness of each as shown on figures 1 through 3 is arbitrary. The rise in the gravity values at the south end of profile A-A' may be due to intrusive rocks such as granodiorite, which has a density similar to the Precambrian rocks of the study area.

Profile B-B' (fig. 2) crosses a 24-mGal, cir gravity low (anomaly C). When modeled using the densities mentioned above, it reflects a complex structure (fig. 2) about 23,000 ft in diameter ha a total depth of approximately 26,000 ft. The circular character of this gravity low suggests a buried low-density intrusion or plug surrounded b higher density Wiggins intrusives (Rankin, writte commun.). Better definition of the structure wou require additional detailed geophysical studies.

Profile C-C' (fig. 3) across the South Fork Shoshone River was made to help determine the dep the alluvium in the river basin. Model C-C' was computed assuming a density of 2.53 gm/cm³ for a Tertiary basement and 2.0 gm/cm³ for wet gravels (Telford and others, 1978). This resulted in a thickness at the deepest point of 246 ft and a reasonable fit to the observed profile C-C'.

AEROMAGNETIC SURVEY

METHODS

The aeromagnetic survey (U.S. Geological Su 1973) was flown at a barometric elevation of 13, 13,500 ft. Flight lines were oriented north-sou spaced approximately 1 mi apart. The data were compiled and projected on a Universal Transverse Mercator projection at a map scale of 1:125,000, contour intervals of 20 and 100 gammas.

Rock magnetism in the study area was not measured, and it is readily apparent that most o anomalies are related to the extreme topographic relief of rocks in the Absaroka Volcanic Supergr The generally high intensity of magnetization of volcanic rocks makes interpretations of other so difficult. Therefore only magnetic anomalies a trends believed to have the greatest geologic significance are identified. These are interpre conjunction with geologic and gravity data.

MAGNETIC DATA

The stratified rocks of the Absaroka Volca Supergroup are subdivided into three groups, fr oldest to youngest, the Washburn Group, the Sun Group, and the Thorofare Creek Group (Smedes an Prostka, 1972). The total-intensity map (U.S. Geological Survey, 1973) from south to north sh increase in the amplitude and frequency of anom across line MT-1; this may indicate a lithologi change and (or) a thicker section of the older, mafic rocks of the Washburn and Sunlight Groups northern side of the study area.

Fisher (1981) discusses eleven known mine sites in the study area. For these, magnetic correlations are not obvious, and three major make detailed analysis of the magnetic anomali difficult. (1) Generally, aeromagnetic survey minerals are flown normal to the main and geol trend (Telford and others, 1978), but this sur which was flown north-south, almost parallels trend of the intrusive centers. (2) The study has a complex magnetic stratigraphy consisting series of normally magnetized flows and a seri reversely magnetized flows (Fruss, 1975). Th result in an unknown total magnetization vecto remnant and (or) permanent component. (3) Be extreme topographic relief, the distance from magnetic sensor on the aircraft to the volcan surface rocks was highly variable over the st causing numerous strong complex anomalies and obscuring anomalies that could be associated mineral deposits.

Two significant magnetic anomalies can b to the geology and structure of the study are is the negative anomaly M-A in the southeast corner of the mapped area. This anomaly coin with the rhyolitic Dollar Mountain pluton (Ra loops were closed daily using a temporary base written commun.), which contains a Paleozoic pendant. This large magnetic low probably re magnetic deficiency in the pluton compared wi surrounding Absaroka Volcanic Supergroup rock

A second magnetic low (M-B) at the north corner of the study area has a north-south el and a steep gradient near its west edge. It p reflects a west-dipping basin formed by the h Canyon Creek fault (Rankin, written commun.).

CONCLUSIONS

Magnetic anomalies in the Washakie Wild area are mostly controlled by highly magnetic volcaniclastic surface rocks in a setting of topography. Magnetic anomalies that might i changes in rock composition are masked by th topographic effect. Because the gravity ano reflect deep structure and lithology, they c poorly with the magnetic anomalies, which re mostly surface sources.

Large-scale subsurface structural patte delineated by the gravity data include seven northwesterly trends that parallel Laramide of the eastern foreland (Nelson and others, probably reflect similar features buried bea Absaroka Volcanic Supergroup (Rankin, writte commun.). Gravity trend 1 correlates well w northwest line of intrusive centers that ind known mineralized areas; therefore further s be worthwhile.

The northwest-trending gravity low at southeast side of the study area implies a feature, possibly a deep sedimentary basin be related to the Younts gravity basin sout the area. Several gravity highs, some enc northwest trends, coincide with known occ (Antweiler and others, 1985) and imply base highs. The graben-like feature and the ar enclosed gravity highs would require further geophysical exploration to define them as p structural traps for hydrocarbons.

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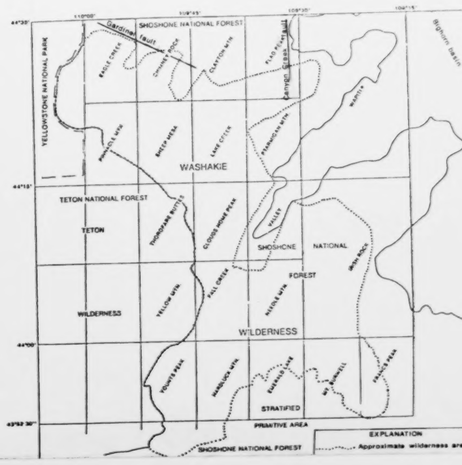

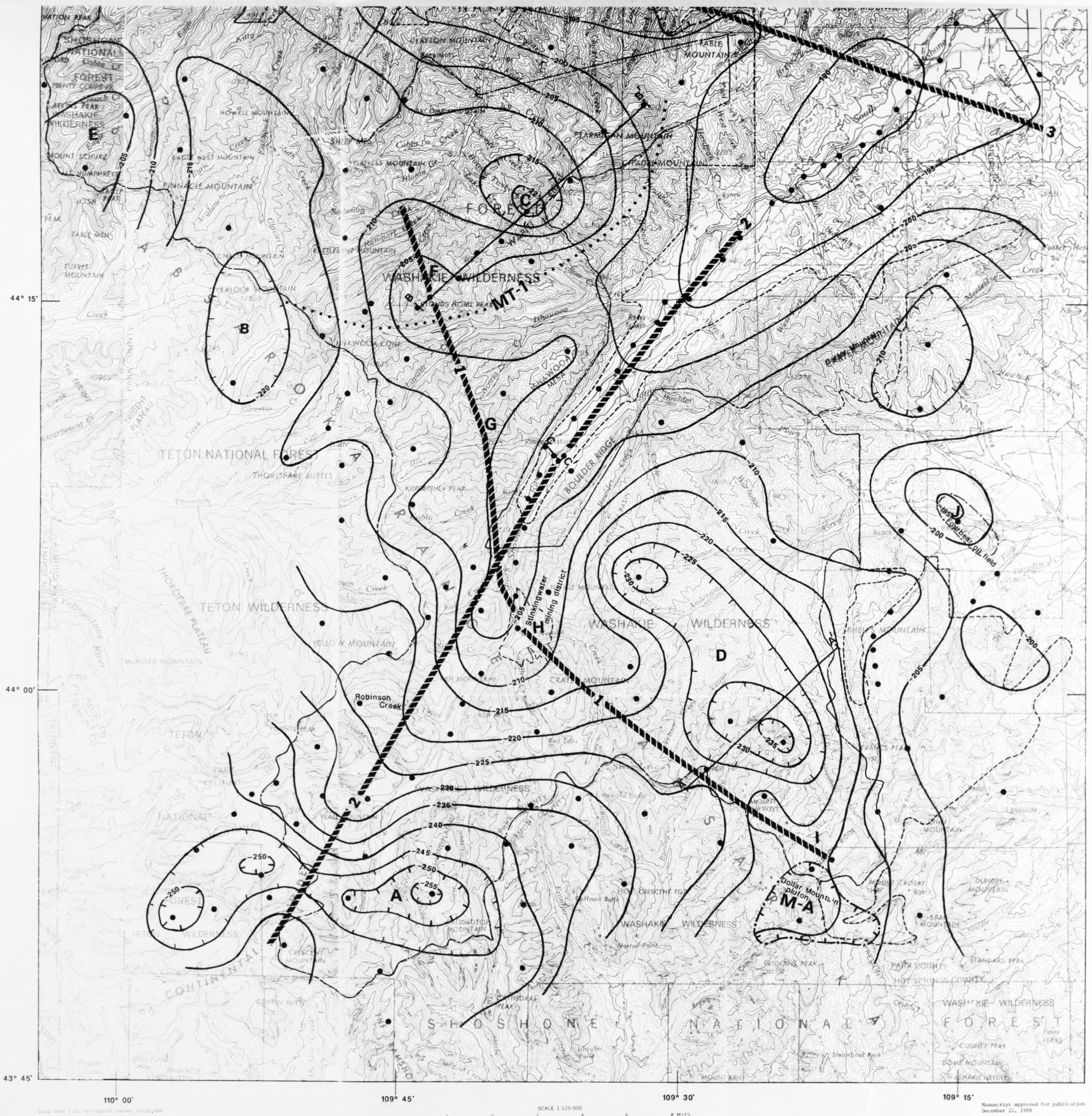

Base from U.S. Geological Survey 1:250,000
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Two significant magnetic anomalies can be related to the geology and structure of the study area. One is the negative anomaly M-A in the southeast corner of the mapped area. This anomaly coincides with the rhyolitic Dollar Mountain pluton (Rankin, written commun.), which contains a Paleozoic roof pendant. This large magnetic low probably reflects a magnetic deficiency in the pluton compared with surrounding Absaroka Volcanic Supergroup rocks.

A second magnetic low (M-B) at the northeast corner of the study area has a north-south elongation and a steep gradient near its west edge; it possibly reflects a west-dipping basin formed by the high-angle Canyon Creek fault (Rankin, written commun.).

CONCLUSIONS

Magnetic anomalies in the Washakie Wilderness area are mostly controlled by highly magnetized volcaniclastic surface rocks in a setting of extreme topography. Magnetic anomalies that might indicate changes in rock composition are masked by the topographic effect. Because the gravity anomalies reflect deep structure and lithology, they correlate poorly with the magnetic anomalies, which reflect mostly surface sources.

Large-scale subsurface structural patterns delineated by the gravity data include several northwesterly trends that parallel Laramide structures of the eastern foreland (Nelson and others, 1980) and probably reflect similar features buried beneath the Absaroka Volcanic Supergroup (Rankin, written commun.). Gravity trend 1 correlates well with the northwest line of intrusive centers that include most known mineralized areas; therefore further study might be worthwhile.

The northwest-trending gravity low at the southeast side of the study area implies a graben-like feature, possibly a deep sedimentary basin, that could be related to the Younts gravity basin southwest of the area. Several gravity highs, some enclosed with northwest trends, coincide with known oil fields (Antweiler and others, 1985) and imply basement highs. The graben-like feature and the area of the enclosed gravity highs would require further detailed geophysical exploration to define them as potential structural traps for hydrocarbons.

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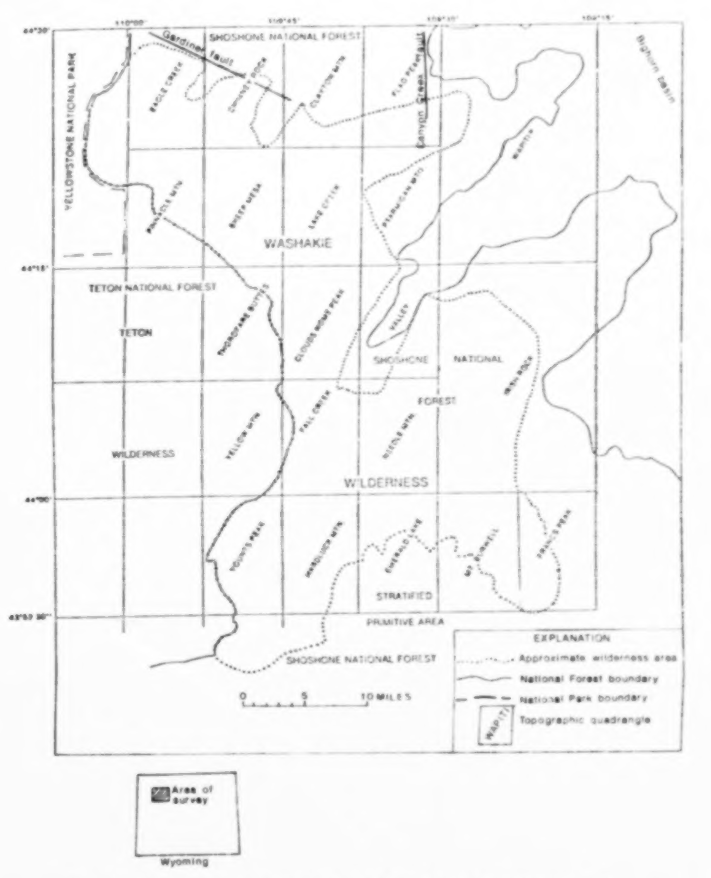

Figure 1.--Location map of gravity survey for the Washakie Wilderness and study area contiguous to the North Absaroka and Washakie Wildernesses.

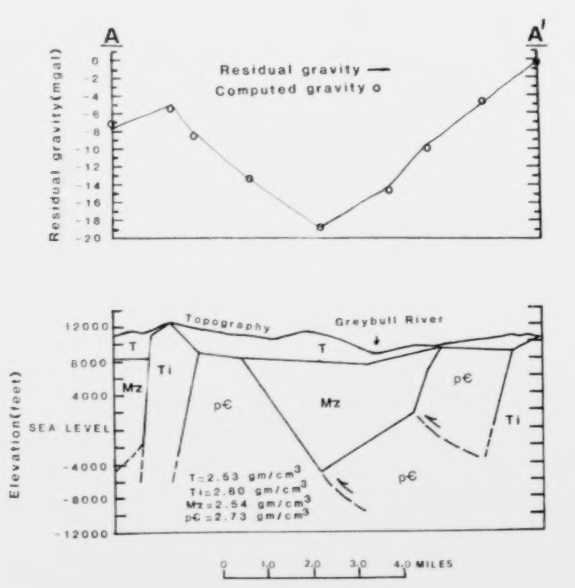

Figure 2.--Gravity profile across anomaly D, and model of implied geologic section. Symbols used: T, Tertiary; Mz, Mesozoic; p€, Precambrian; Ti, Tertiary intrusive.

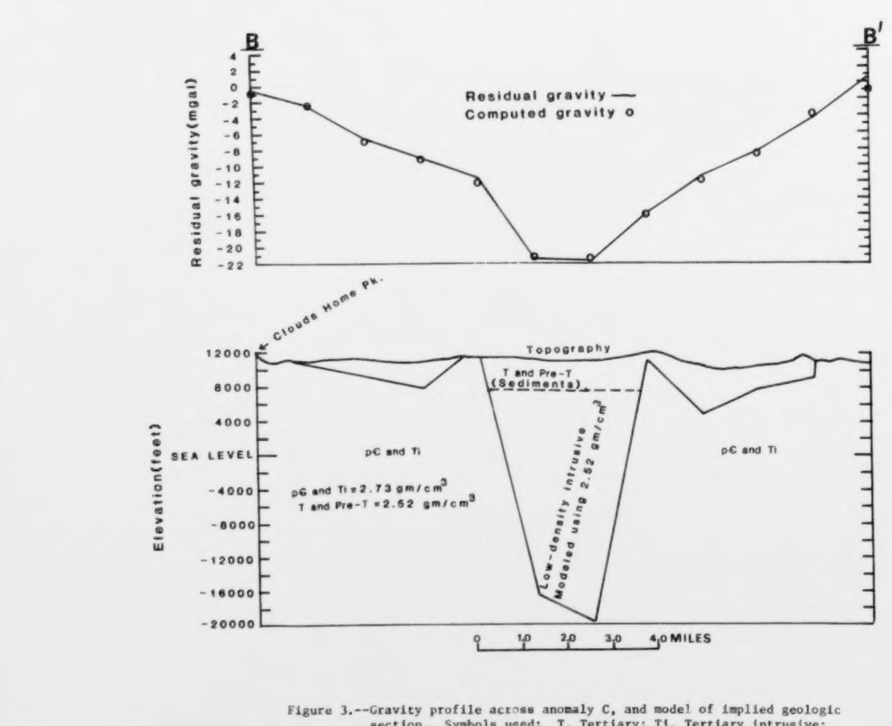

Figure 3.--Gravity profile across anomaly C, and model of implied geologic section. Symbols used: T, Tertiary; Ti, Tertiary intrusive; p€, Precambrian.

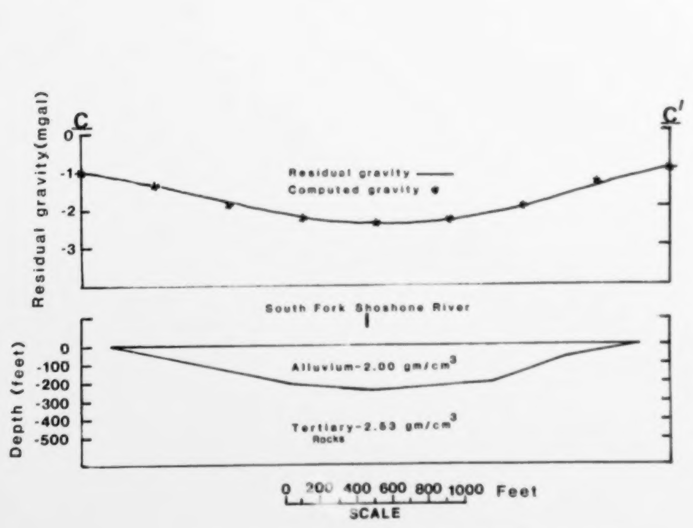

Figure 4.--Gravity profile and model of implied geologic section.

GEOPHYSICAL SURVEY MAP OF THE WASHAKIE WILDERNESS AND ADJACENT ROADLESS AREAS, PARK COUNTY, WYOMING

By
Carl L. Long

1989

Any use of trade names in this publication is for descriptive purposes only and does not imply endorsement by the U.S. Geological Survey.

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